$e^+e^- \rightarrow \tilde{t}_1\overline{\tilde{t}}_1 \rightarrow c\tilde{\chi}_0^1\overline{c}\tilde{\chi}_0^1$ Update-9May-05

C. Milsténe, A. Freitas, M. Carena – Fermilab; A. Finch, A. Sopczak – Lancaster; H. Nowak –DESY

LCWS05: http://theory.fnal.gov/people/freitas/lcws/milstene.pdf

- In the project are involved both experimentalists and theorists for the span of the channels under study to SUSY-MSSM and Cosmology, at once, where the neutralino is a suitable candidate for dark matter
- The c-tagging puts stringent conditions on the Vector Detector which could be used as a detector benchmark

Simulation Characteristics

- Background generated in the framework:

  Pythia + Simdet + Circe

  a) Beamstrahlung & Bremstrahlung Simdet code implementation by A. Finch

  b) Stop to neutralino non-standard Pythia code of A. Sopczak.
- Signal and Background generated in each channel in conjunction to the cross-sections:

Signal And Background Cross-Sections (pb)

Process $\tilde{t}\ \tilde{t}$	Beamst/ISR	FREITAS		
		unpol	L-pol	R-pol
M ($\tilde{t}$=120)	yes	0.2802		
M ($\tilde{t}$=140)	yes	0.21670	0.19635	0.23714
M ($\tilde{t}$=180)	Yes	0.10532	0.09532	0.11527
M ($\tilde{t}$=220)	yes	0.02487	0.02253	0.02720

The Events have been produced with Beamstrahlung

σ-normalizations without.

Process	Pythia Isub	Beamst/ISR	GRACE		
			Unpol	L-pol	R-pol
ww	7.38 - 25	no	7.6141	15.172	0.05624
Wenu	5.30 - ~36	no	6.142	9.268	3.016
ZZ	0.402 - 22	no	0.44000	0.6250	0.25501
eeZ	6.90 - 35	no	7.64	8.42	6.72
tt	- 1	no	0.56651	0.79536	0.33765
qq*	- 1	yes	13.974	18.345	10.941
γγ-Beamst.	782 - A.F	yes			
2-photon	154 - A.F	yes			

** A. Freitas 's program*

Selection $e^+e^- \to \tilde{t}_1\bar{\tilde{t}}_1 \to c\tilde{\chi}_0^1\bar{c}\tilde{\chi}_0^1$

• Pythia with Simdet/Tesla was used for the simulations of both signal and background with CIRCE for the beamstrahlung.

•A short list of the sequential cuts applied as a preselection first, allowed larger samples to be produced and the cut refined at selection stage.

Pre-selection:

•4<Number of Charged tracks<50

•Pt> 5 GeV

•$\cos\theta_{Thrust}$ <0.8

•$|P_{l,tot}/P|$<0.9

•E_{vis}<380 GeV

•M(inv)<200 GeV

Selection: LCWS05		NOW: c-tagging (T. Kuhl)
•Njets =2	→	2
•Cos (A-coplanarity) <0.9	→	0.95
•$\cos\theta_{Thrust}$<0.7 , P_t >12 revisited.	→	$\cos\theta_{Thrust}$<0.7 , P_t >12 revisited
•E_{vis}<200GeV	→	E_{vis}<200GeV
•2000 GeV^2 < $Minv^2_{jets}$ < 9000 GeV^2	→	3500 GeV^2 < $Minv^2_{jets}$ < 8000 GeV^2

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Selection: The Background Rejection LCWS05 && Now

Background	% Left - End Presel	NumberGen. Selection (LCWS05)	NumberGen. Selection (now)	Num Left. End Sel. – For 500 fb^-1 (LCWS05)	Num Left. End Sel. – For 500 fb^-1 (NOW)
γγ- Beamst.	0.06%	2.2 Millions	4.5 Millions	0. 200.	0. 88.5
2- photon	0.04%	1.0 M	1.0 M	0. 77.	0. 77.
zz	9%	0.03 M	0.03 M	30. 220.	36. 263.
qq	0.09%	0.35 M	0.35 M	10. 200.	8. 160.
ww	1.45%	0.21 M	0.21 M	10. 181.	8. 145.
tt	1.36%	0.18 M	0.18 M	25. 400.	25. 400.
wenu	25.70%	0.21 M	0.21 M	624 9123.	371 5424.
eez	0.06%	0.21 M	0.21 M	3 55.	2 36.

Improvements :in Background rejection comes from the ctag implementation, except in the γγ- Beamst. which comes from increased statistics, the rejection provided by the pt cut. The zz rejection is very slightly worse

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Selection: The Signal

M ($\tilde{t}$)	% Signal End Preselection	Num. Gener. Selection	Num. Signal End Sel-For500fb^-1
140GeV			
Δm=20	65.8%	50 K	20080 -39950
Δm=40	68.2%	50 K	18440 -20380
Δm=80	50.1%	50 K	12920 -19890
180GeV			
Δm=20.	67.2%	25 K	14440 -15430
Δm=40	72.3%	25 K	9753 -11230
Δm=80	63.7%	25 K	9178
220 GeV			
Δm=20	66.1%	10K	4608
Δm=40	74.1%	10K	2578
Δm=80	72.8%	10k	2734

In Red Improvements Due to:

c-tagging
+
Relaxed A-coplanarity Cut 0.95 (instead of 0.9)

C-tagging-The Principle

A Vertex Identification followed by a Neural Network application

•*Vertex Identification*:

As a maximum in track overlapping (product of probability density tubes defined the track parameters)

3 cases:

Case 1) Only a primary Vertex

Case 2) 1 secondary vertex

Case 3) >1 secondary vertex

•*Neural Network (NN):*

data: 255000 stops, Mstop=120-220; Dm=5,10, 20 GeV

240000 Weν, the most resilient background

C-tagging-Neural Network Input

•<u>Vertex Case 1</u>:NN Input variables

- *Impact parameter* significance (impact parameter/error) of the 2 most significant tracks in the r-Φ plane && their Impact parameters.
- The impact parameter significance & Impact parameters of the 2 tracks in z
- Their momenta
- The joint probability in r- Φ & z

•<u>Vertex Case 2</u>: NN Input variables (all of Case 1+below)

- *Decay Length* significance of the secondary vertex && Decay Length
- Momentum of all tracks associated to the secondary vertex && Multiplicity
- Pt corrected mass of secondary vertex (corrected for neutral hadrons&ν's), the pt of the decay products perpendicular to the flight direction (between primary && secondary Vertex) && joint probability in r-Φ and z

•<u>Vertex Case 3</u>: 2 secondary vertices, the tracks are assigned to the vertex closest to the primary vertex and the NN input variables are those of case 2

Discovery Reach

Δm	Eff. Mstop = 120GeV	Eff. Mstop= 140GeV	Eff. Mstop= 180GeV	Eff. Mstop= 220GeV
5 GeV	2.71%- 23.5%	1.15%- 20.23%	0.30%- 14%	0.11%- 8.5%
10 GeV	20.3%- 34.53	21.1%- 35.04%	19.1%- 34.6%	35.3%- 69%
20 GeV	19.0%- 33%	18.5%	27.4%	37.1%
40 GeV		10.2%	18.5%	20.7%
80 GeV		11.9%	18.3%	22.0%

<u>In Green</u>: with c-tagging <u>alone</u>- the actual pt cut of12GeV “against” the 2-photons being now the most harmful for low Dm signal (should be replaced)

Conclusions / Outlook

- C-tagging implemented
- Tuning of c-tagging for small Dm
- C-tagging reduced largest background Weν by half (tuned c-tagging)
- Other cut relaxed: acoplanarity

- Next: optimize signal vs background, use of Iterative Discriminant Analysis (IDA)
- Redo for different vertex detectors (material/design)
- Focus on very small Dm (far beyond hadron colliders)
- Further interpretations for cosmological relevant parameter combinations (Ayres, Marcela)
- Longer term: TESLA/SLAC detector comparisons.
- GEANT4 simulations and/or other fast-simulations.

Backup

C. Milsténe

Background ()

- Remark:

  In the Beamstrahlung are included processes

  131,135,11,12,13,28,53,68

  In the Bremstrhalung

  11,12,13,28,53,68,131,132,135,136,137,138,139,140….